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Title of Research:

"Origin of High X-Ray Luminosities in Optically Passive Galaxies" and "Resolving the Source of X-Rays in IC1613"

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Annual Status Report for

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"The Origin of High X-ray Luminosities in Optically Passive Galaxies"
and
"Resolving the Source of X-rays in IC1613"

This report covers progress to date on two unrelated programs awarded time and funding under ROSAT AO5. In both cases, the data have now been received and analyzed, although additional time is required before publications are complete.

"The Origin of High X-ray Luminosities in Optically Passive Galaxies"

The basis for this proposal was our discovery in a sample of radio-selected *Einstein* sources of a class of galaxies which have X-ray luminosities in excess of 10^{43} erg/s and yet give no sign whatsoever in their optical spectra that they harbor active galactic nuclei (AGN). The *ROSAT* HRI observations are part of a multiwavelength campaign to understand these systems which includes deep optical imaging, high-resolution VLA imaging, and radio and optical spectroscopy. The three brightest X-ray sources were chosen for inclusion in this program.

All three objects have now been observed, albeit with less than the approved integration time in two of the three cases; data on the final object arrived on March 1, so analysis is not yet complete. All three fields contain several detected X-ray sources, and in at least two of the cases, the target appears to have been detected (the third case is unclear, as the object first detected with *Einstein* may be extended). We are attempting to identify all sources in the fields in order to estimate the astrometric offset of the *ROSAT* coordinate system in each field, as this is crucial to determining whether or not the source in question is coincident with the nucleus of the apparent host galaxy. Optical imaging data to be collected this month should complete this effort, allowing us to interpret these sources and to determine whether or not they might play a role in comprising the cosmic X-ray background.

"Resolving the Source of X-rays in IC1613"

IC1613 is the only dwarf galaxy in which a strong X-ray source was detected in the *Einstein* survey of the Local Group. Analysis with the flatfielded data derived from the Columbia *Einstein* processing system suggested that the source was extended. In addition,

T. Lozinskya pointed out that the source was located close to the most lumnious Oxygen Wolf-Rayet star in the Local Group, suggesting the possibility that the X-rays originated in the hot cavity evacuated by the high-velocity stellar wind emanating from this star. The HRI observation was scheduled to determine the precise location and extent of the X-ray source and, in doing so, to understand its relationship to the ongoing star formation activity in this galaxy.

At about the time of the observation, P. Eskridge circulated a preprint reporting the discovery of a cluster of galaxies at $z \sim 0.2$ behind IC1613, and postulating that the *Einstein* X-ray source was the intracluster medium of that cluster seen through the foreground galaxy. The HRI data have allowed us to confirm this conjecture for the bulk of the X-ray emission, while revealing at least one bright X-ray source which is definitely associated with IC1613.

A total of 22,765 sec of good integration time was achieved at the target position. The image is dominated by a bright diffuse source centered at RA = 01^h05^m, Dec = $02°01'$ which is nearly $2'$ in diameter. This is clearly emission from the background cluster. At least two significant point sources are also found in this vicinity, and their association with the cluster cannot be ruled out. Two of the other sources in the field are bright Galactic stars, and we are using these to register the *ROSAT* image precisely.

The aforementioned Wolf-Rayet star is located just north of the cluster center. An apparent extension of the diffuse emission in this direction could represent a contribution from the WR star nebula; deep narrow-band optical images were taken of this region at the KPNO 4-m in December in an attempt to determine the full extent of the star's wind-blown bubble in order to use this as an input in attempting to deconvolve the stellar and cluster X-ray emission.

Perhpas the most interesting result of the observation, however, concerns neither the moderate-redshift galaxy cluster nor the WR star, The second brightest source in the HRI image lies $8'$ north of the cluster in a region of active star formation in the galaxy. The source turns out to be coincident with a radio-bright supernova remnant in IC1613. The object has been resolved with the VLA and is about 6×9 pc in extent; it has the steep spectral index of a shell-like remnant although its morphology is not clearly a shell. The X-ray luminosity is considerably greater than that of Cas A, making it one of the most luminous remnants in the Local Group. The optical data available on the object is confused — it is even classified as a WR star rather than a remnant in one paper; its published spectrum shows many strong FeII lines as well as a weak continuum. The latter may arise from a superimposed foreground star, and we have taken deep 4-m images in an attempt to resolve this matter. Our two attempts to obtain new optical spectroscopy failed due to

weather and will be repeated in the coming year.

Prof. Tatiana Lozinskya from Moscow State University, a co-Investigator on this *ROSAT* observation, spent a very productive two-month visit at Columbia in which we conducted a complete literature search, analyzed the X-ray and VLA data on this object, and outlined the paper. The remaining tasks include finishing the astrometric alignment and reducing the optical imaging data in order to form a complete picture of the X-ray emission from IC1613 and its superposed cluster of galaxies.